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STATUS REPORT

NASA RESEARCH GRANT NAGW-1567

"A Correlative Investigation of the Propagation of ULF Wave Power Through the Dayside Magnetosphere"

July 1, 1991 - December 31, 1991

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I. Overview

NASA grant NAGW-1567 was awarded to Augsburg College to support a multisatellite study of the propagation of ULF wave power through the dayside magnetosphere. Project funding began in January 1989, and was extended through June 1992.

During the period covered by this report, July 1, 1991 through December 31, 1991, we continued work in each of the major areas of study proposed for this project. One paper was submitted to the Journal of Geophysical Research during this period, and is now under revision. Four presentations were made at scientific meetings, and work continues to prepare other studies for submission to journals.

II. Scientific Accomplishments

A. Analysis of Radially Polarized Pulsations

The first study supported by this grant was of radially polarized pulsations, which appear to occur in radially restricted regions at local times from prenoon through dusk [Murr et al., 1989]. David Murr, an undergraduate student, had done an excellent job of identifying a large number of events observed by all three of the satellites involved in this study (AMPTE CCE, GOES 5, and GOES 6). The search for a physical mechanism to drive these pulsations, however, led Dr. Engebretson, project P. I., to study the available particle and plasma wave data as well. In July/August 1991 Dr. Engebretson obtained particle density, plasma composition data, and plasma moments for nine of the pulsation events in this study during a week's visit to work with Drs. David Klumpar and Stephen Fuselier of Lockheed Palo Alto Research Laboratory. A poster paper including this more recent work was presented at the IAGA/IUGG meeting in Vienna, Austria in late August [Murr et al., 1991a], and shortly thereafter at an international AMPTE project team meeting in Munich, Germany. Final revisions were made as a result of helpful comments received at these meetings, and a paper was submitted to the Journal of Geophysical Research October 7, 1991, and is now under revision [Engebretson et al., 1991b].

We have found that the radially polarized waves studied in this paper are associated with a refilling, extended outer plasmasphere; that they are temporally associated with low values of the AE index, and that they are only weakly associated with increases in plasma beta, if at all. Beta values above 0.25 may be a necessary condition for wave onset, but are certainly not a sufficient condition. They appear to be driven by a bounce resonance instability, but unfortunately, the available time resolution of much of the particle instrumentation on AMPTE CCE limits our being able to verify this hypothesis. We have, however, found less reason to invoke a pure ballooning instability than we had earlier anticipated.

B. Impulse Event Studies

The second study begun under this grant involved multisatellite observations of an SI event in 1984. A manuscript on this event is nearly completed, but in order to understand the AMPTE CCE hot plasma data, again provided by Lockheed, we have during the past six months studied several additional SI events, many of which were also evident in ground data from several instruments including magnetometers at South Pole and Siple, Antarctica, and Sondrestromfjord, Greenland. Each of these events shows complex electron structure that appears to be evidence of unusual particle transport processes into the outer magnetosphere, and may be helpful to our understanding the means by which impulsive electron precipitation and ground magnetic signatures are produced in association with these impulses.

As a result of this joint effort, two coordinated poster presentations were made at the Fall 1991 AGU meeting [Murr et al., 1991b, Klumpar et al., 1991]. In the first category of event (typified by Figure 1) a complex but temporary compression and twist of the magnetic field at AMPTE CCE was accompanied by a two-stage electron signature: a heating and rarefaction of the electron flux, lasting 4-5 minutes, and embedded within it a primarily field aligned, denser, and colder flux of electrons, lasting only ~ 1 minute. Magnetic field data from the GOES satellites, located near the dawn flank at synchronous orbit, showed a slight field distortion some 3-4 minutes later, at which time damped, azimuthally polarized fundamental (Pc 5) resonant pulsations were also established at the location of each satellite. In each of the five cases when AMPTE CCE near noon saw similar magnetic field and electron flux signatures and the GOES satellites were located near the dawn or dusk flanks on the dayside, such damped resonant pulsations were established. In the one case when all three satellites were positioned near local noon, however, only a weaker, longer period resonance was established at each location.

In two other cases (typified by Figure 2) a more sustained compression of the field was observed at all three satellites, and a quite different electron signature was observed. Again, resonant pulsations were established near the dawn flank.

Although the Lockheed HPCE instrument's ion sensor on AMPTE CCE was not often in a mode with time resolution suitable to detect a similar response to these SI events, data obtained in two events of the first category indicates no ion signatures of hotter or cooler plasma simultaneous with the electron signatures, but does indicate the presence of a significantly delayed (~5 min) ion beam. We interpret this as evidence that both the ions and electrons have their source in the ionosphere, perhaps as a backscatter from the prompt downward signal of the SI, rather than as an intrusion of a boundary layer or magnetosheath population inward past the satellite. During spring 1992 David Murr plans to write up his part of this study as a senior honors project, and Drs. Engebretson and Klumpar will continue to prepare their parts of this investigation for publication.

C. Radial Boundaries of Pc 3-4 Pulsations in the Dayside Magnetosphere

The scientific objectives listed in our proposal for this project included a better understanding of how Pc 3-4 pulsations, which appear to be externally generated, enter the magnetosphere; how they are transported throughout the dayside magnetosphere; and whether there are any similarities between the entry/transport of these pulsations and of longer period Pc 5 pulsations. The study of Ho et al. [1991], reported at the 1991 Spring AGU Meeting in Baltimore, indicated surprising radial boundaries of dayside Pc 3-4 wave activity under geomagnetically quiet conditions. As with our earlier study of longitudinal localization, these observations favor the recently published model of Pc 3-4 wave entry [Engebretson et al., 1991a], but are difficult to reconcile with conventional models of equatorial wave entry.

Although we often observed simultaneous harmonically structured, azimuthally polarized Pc 3-4 pulsations at all three satellites when they were on the dayside, we noticed that at times these pulsations did not appear at the GOES satellites even though they did appear at higher L shells at AMPTE CCE. An investigation of these events has led us to conclude that radial boundaries of pulsation occurrence exist in the dayside magnetosphere, and has given evidence that they may somehow be related to plasmaspheric boundaries, boundaries of the corotation electric field, or the region 2 Birkeland currents. Our study of three-satellite magnetic field data has been expanded in this case toinclude plasma wave data from the AMPTE CCE plasma wave experiment (PWE). We have als made use of spectrograms of AMPTE CCE magnetic pulsations at lower L shells prepared by K. Takahashi.

A more complete description of these events was provided in our previous status report. An updated poster presentation was given at the IAGA/IUGG meeting in Vienna [Engebretson et al., 1991c], and we hope to submit a paper on this study during spring 1992.

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Figure 1a: Magnetic local time – L value plot of the AMPTE CCE, GOES 5, and GOES 6 satellite orbits from 1100 to 1400 UT October 9, 1984 (day 84283). The time of the compression event is highlighted on each orbit trajectory.

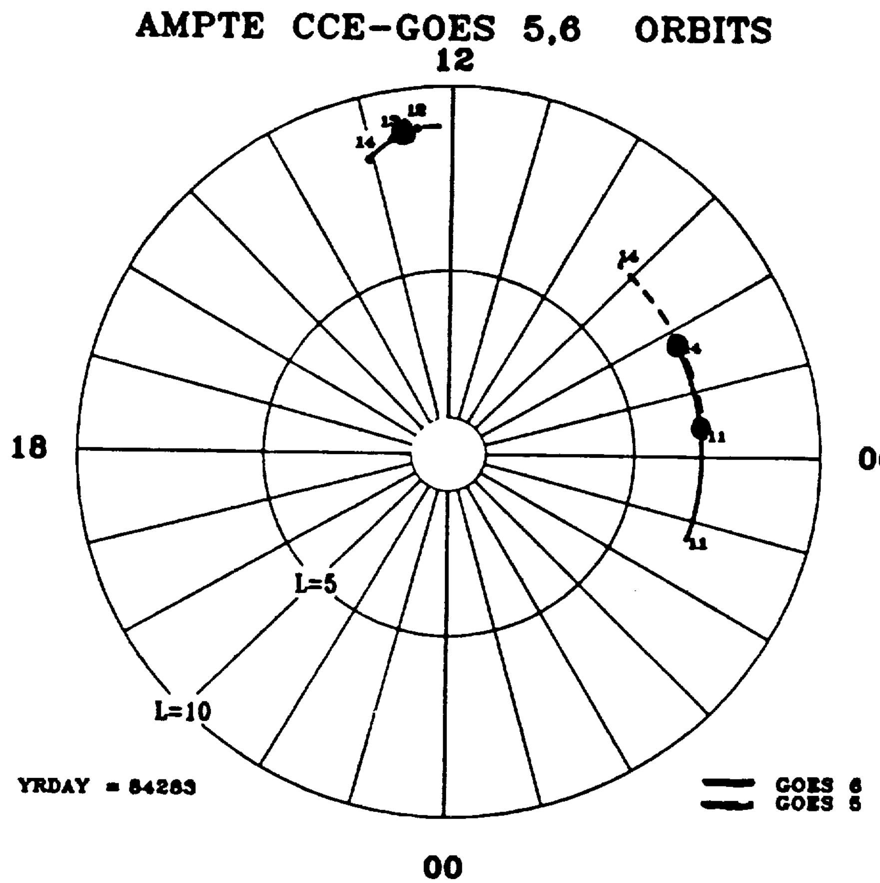

Figure 1b: Radial, azimuthal (eastward), and compressional (northward) components of the magnetic fields observed by AMPTE CCE, GOES 5, and GOES 6 (top three panels), and the electron temperature and number density observed by the Hot Plasma Composition Experiment (HPCE) on AMPTE CCE (bottom panel) from 1200 to 1300 UT October 9, 1984. The zero level of each component plot is arbitrary.

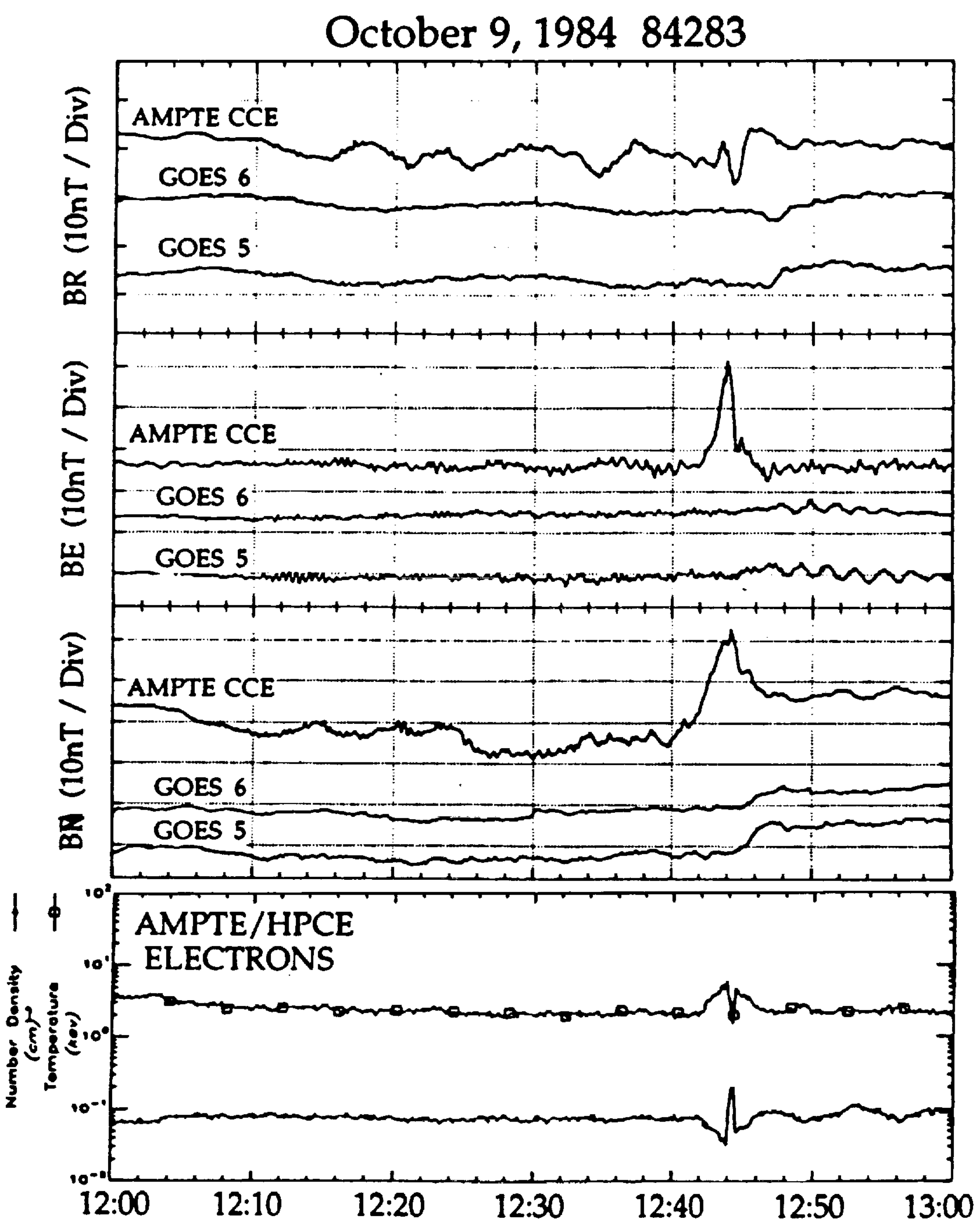

Figure 2a: Magnetic local time – L value plot of the AMPTE CCE, GOES 5, and GOES 6 satellite orbits from 1000 to 1300 UT November 12, 1984 (day 84317), as in Figure 1a.

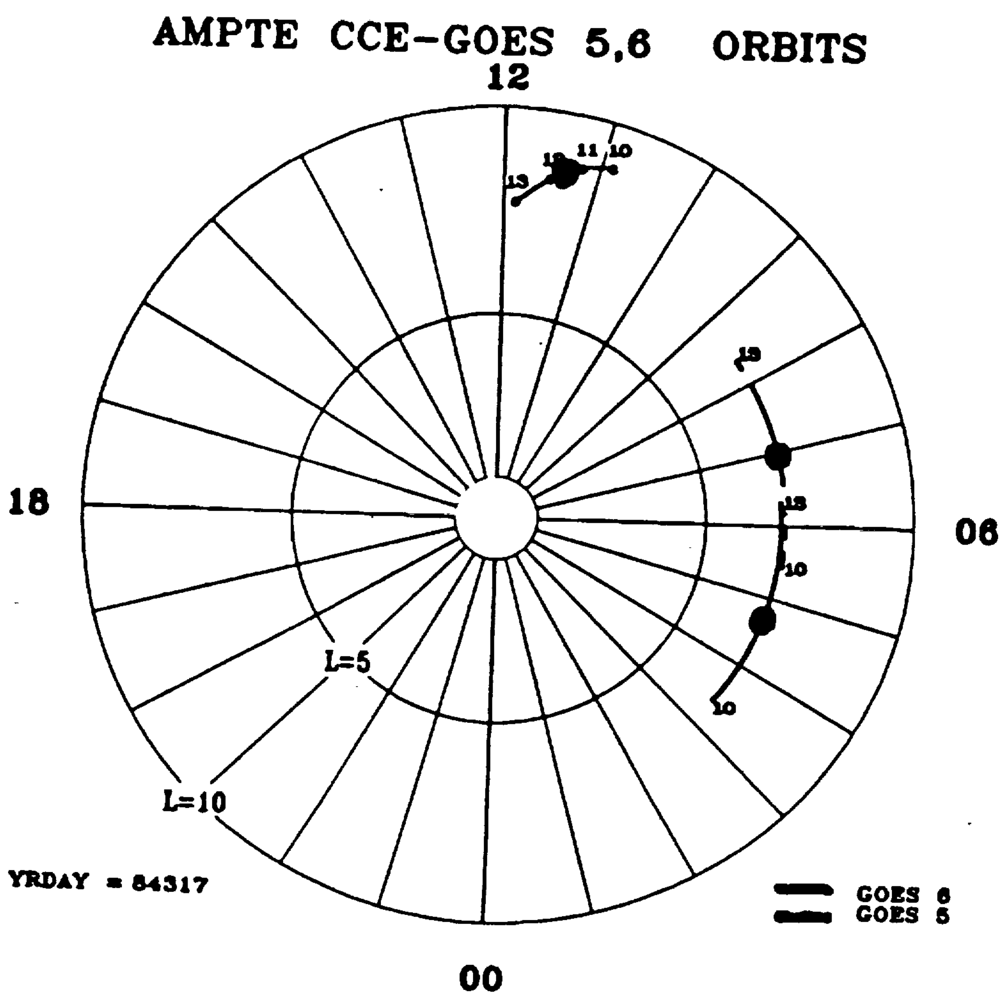

Figure 2b: Radial, azimuthal, and compressional components of the magnetic fields observed by AMPTE CCE, GOES 5, and GOES 6, and the electron temperature and number density observed by the Hot Plasma Composition Experiment (HPCE) on AMPTE CCE from 1100 to 1200 UT November 12, 1984, as in Figure 1b.